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DEFENDANTS' MOTION TO EXCLUDE
THE TESTIMONY OF
DR. CHRISTOPHER TEAF

05-CV-0329 GKF-PJC

Eutrophication of Tenkiller Reservoir, Oklahoma and Effects on Water Quality and Fisheries

Expert Report of Dr. G.D. Cooke and Dr. E.B. Welch

for

State of Oklahoma

in

Case No. 05-CU-329-GKF-SAJ

State of Oklahoma v. Tyson Foods, et al.

(In the United States District Court for the Northern District of Oklahoma)

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State Index (TSI-TP) of 63 (mid-eutrophic), a common TSI at LK-04 (P concentration of 60 µg/L; see Figure 7, data in Appendix B). Mean TP-TSI at LK - 03 was near this value (Figure 7). A chl concentration of 10 µg/L or less is considered "low risk," but chl at 50 µg/L is "medium risk" (WHO, 1999). Tenkiller exhibits low chl at LK-01 and LK-02, but well above 10 µg/L during summer months at LK-03 and LK-04 (violating Oklahoma water quality standards) (OAC 785:45-5-10). Thus, Tenkiller appears to be near a P threshold, past which the risks of high MC concentrations are more likely. Shoreline scums (see Figure 43), caused by wind concentration of floating blue-green algae cells, colonies and filaments, may produce locally high levels of MC and other toxins near raw potable water intakes, and in swimming areas thereby violating Oklahoma's water quality standard for primary body contact recreation (OAC 785:45-5-16).

Continued and increased P loading to Tenkiller will make it more eutrophic over a wider area, increasing the risk of higher MC concentrations and other cyanobacterial toxins. It is difficult to reverse the trophic state of very eutrophic systems due to P recycling from P-rich sediments (Cooke et al. 2005), suggesting that Tenkiller may experience blue-green algal blooms well into the future.

A final major concern regarding Cyanobacteria toxins in Tenkiller involves potable water treatment. Numerous studies (e.g. Yoo et al. 1995; Stone and Bress, 2007; Pitois et al. 2001) found that conventional raw water treatment (coagulation, sedimentation, filtration, chlorination) is ineffective at MC removal. The most effective treatment may be granular activated carbon (GAC), but use of GAC requires that the utility have an expensive toxin monitoring program, or use GAC continuously. Most potable water utilities at Tenkiller are small (Table 1) and may not have the resources for monitoring and/or continuous GAC operation. Tap water consumers at these utilities may be at risk for chronic exposure, including exposure to algal toxins generated at P-rich LK-04 and washed down the reservoir.

Microcystin was detected at two of five sites in Tenkiller in July, 2005 (Lynch and Clyde, 2006). The concentration at one site was 0.35 µg/L, whereas the second site had a concentration of 3.3 µg/L. The higher MC concentration, while above the WHO guideline of 1.0 µg/L, is considered a low risk concentration for human liver cancer (WHO, 1999). No tap water determinations of algal toxins at Tenkiller were made. CDM sampled Tenkiller near three potable water intakes (Cherokee #2 and #13, Gore PWA) on three dates during summer 2007. No microcystin was found. More extensive and regular surveys at Tenkiller are needed because ideal conditions are developing for large blue-green algal blooms.

The exotic blue-green alga *Cylindrospermopsis raciborskii* was often the dominant alga in the summer phytoplankton of Tenkiller in 2006 and 2007 (CDM data). It was absent in earlier studies (Appendix B). This alga secretes cylindrospermopsin, a toxin to humans (Table 10). Its guideline value is also 1.0 µg/L (Falconer and Humpage, 2005). It is unknown whether this toxin has appeared in potable water from Tenkiller. It was not found during the study by Lynch and Clyde (2006). Chlorination degrades cylindrospermopsin, but only when the organic carbon content of the raw reservoir water has less than 4.0 mg/L total organic carbon (TOC) (Senogles et al. 2000). TOC in